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by

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PARTY LINES.

A party line is a line which has more than two stations, as for example a four party line is a line having four subscribers on the same line. Its distinction from a private line is that a private line simply connects one subscriber with the central office.

Party lines are divided into two classes:

(1). Lines where a code of audible signals is employed to enable the various parties to distinguish their calls from those of others.

(2). Those lines where a system of selective signaling is employed so that any one party may be called up without disturbing any other subscriber on the same line.

The first of these classes are known as the non-selective systems and are divided into two general sub-classes, those in which the instruments are connected in series and those in which the instruments are connected in multiple in the line circuits.

American Telephone Practice by Kempster B. Miller.

Since the object of this thesis is to dwell more on the selective signaling class the writer will not go further into detail of non-selective systems, but will refer those who are interested in same to an article by Kempster B. Miller ,M.E., in Electrical Engineering, August, 1898 on Party Lines.

The selective-signaling class can be divided into three sub-classes.

(a). Those employing step-by-step movements to complete the desired circuit.

(b). Those using the harmonic system of selecting-that is, those using currents of various frequencies for actuating the different signals.

(c). Those using currents of different strengths or polarities or both, for ringing the bells at the different sub-stations.

The "step-by-step" system depends on step-by-step mechanisms located at subscribers stations and controlled from the central station in such a manner as to enable the operator to pick out or select the desired station and ring its bell to the exclusion of all others on the same line. There have been several men who have applied this system to party lines but for some reason or other it has not been used much in actual practice, although there does not appear to be any unsurmountable obstacles in the way of making the system practical. Mr. E.N. Dickerson,Jr. in Jan.,

1879, was the first to apply step-by-step mechanisms to party lines. About the same time, George L. Anders also devised a step-by-step system .

The third system is operated according to the strength and polarity of the current passing through the calling devices. These calling devices may depend for their operatinn on either changes in strength or in direction of a current or both. Of the many systems devised the one by W.W. Dean of the Western Electric company is one of the few examples of a true strength and polarity system. In this system, four stations are placed on each limb of a metallic-circuit line. The two call-bells on each of the limbs at the four stations farthest away from the central office are oppositely polarized and bridged between the respective line wires and ground. The two call-bells on each limb at the four stations nearest the central office are wound for low resistance and placed in the line wires and are also polarized. A relay is provided for each limb, each having a high resistance magnet, and these are bridged to ground at a point between the two high-resistance bells and the two low-resistance bells on each limb. Each of these relays, when operated, serves to ground the opposite limb of the line at that point. The principle of operation is that when a current adapted to ring one of the high-resistance bells at one of the four remote stations will not be of sufficient strength , owing to the high resistance of the circuit, to ring one of the low-wound series bells at

at the four nearer stations. When one of the four nearer stations is to be called, the relay on the limb to which the bell of that station is not attached, is actuated. This grounds the limb of the line on which the desired bell is placed, and therefore cuts out the high resistance bells on the farther end of the line. A current of proper polarity is then sent over this limb, which current is now capable of ringing the desired bell on account of the low resistance encountered.

The second sub-class comprises systems known as the harmonic systems. These depend for their operation on the frequency of the currents used. That is, one calling device will be actuated by a current of a frequency of 60 cycles, while another device on the same line will operate only on a current having a frequency of 20 cycles per second. The Leich Four Party System belongs to this class.

The object of this thesis is to fully describe the operation of this system and to determine the inductance, resistance and capacity of a line over which the instruments will operate reliably, and also the effect of varying the inductance and capacity in the instruments themselves on their reliability of operation.

THE LEICH FOUR PARTY SYSTEM.

This system requires for its operation two different frequencies, the frequencies which have been chosen being 20 and

60 cycles per second. The 20 cycles or low frequency is obtained from a two-pole alternating current ringing machine running at 1200 revolutions per minute. Besides this machine a small power magneto running at a speed of 1200 revolutions per minute, or a hand generator , which if not turned too fast, can also be used. The 60 cycle or high frequency alternating ringing current can be obtained from a regular ringing machine delivering a 60 cycle current. This would require a two-pole machine running at 3600 revolutions per minute or a four-pole machine running at 1800 revolutions per minute, or a six-pole machine running at 1200 revolutions per minute,etc. A high frequency hand generator also is very satisfactory, but if in the city, where there is a 60 cycle alternating current incandescent lighting system, this current may be used through a transformer without the use of a motor generator, the pressure of the transformer not to exceed 90 volts.

In the operation of this system as a four party line,four instruments are connected to one metallic circuit. The talking circuits are metallic. Two of the instruments, one a high and the other a low frequency instrument have their ringing circuits connected between one line wire and the ground, the other two being connected between the other wire and ground. These telephones are operated through a selective key having the required number of buttons, so that either a high or low frequency current may be sent over either

the tip or sleeve of the plug, through the line and bells to the ground. The general arrangements of the four instruments are shown in Diagram A.

This diagram shows that one of the low and one of the high frequency telephoes are connected across the metallic circuit while the other two are connected in the reverse order across the circuit. By depressing the buttons on the key marked A,B,C and D the respective telephones are accordingly operated. Buttons A & B are for low frequency instruments and C & D for high frequency. When either of the buttons are depressed an alternating current will be sent through the ringing circuits of two of the instruments, but the instrument which is so constructed as to operate only at the frequency of the alternating current passing through it, will respond. The talking circuits comprise the transmitter, induction coil, battery and receiver, and are connected between the two outside line binding posts while the ringing circuit is connected between the middle ground binding post and the right hand binding post.

To cause selective operation of the high and low frequency bells condensers and impedance or retardation coils are used. The retardation or impedance coils however are not relays but coils of wire with an inclosing iron core. The arrangements of the ringer circuits in the high and low frequency telephones for both magneto and central energy telephones are shown in Diagrams B & C.

The ringing circuit of the low frequency instruments, as shown in Diagrams B & C, consists of a ringer of 1000 ohms, an impedance coil of 2000 ohms, and a condenser of 2 micro-farads capacity, all connected in series. The ringer operates on a frequency of 20 cycles or less. When an alternating current is flowing through an impedance coil the opposition it meets with depends on the frequency of the current. This can be shown by the familiar formula for alternating currents,

$$C = \frac{E}{\sqrt{R^2 + (2\pi f L)^2}}$$

The higher the frequency, the greater will be the expression $\sqrt{R^2 + (2\pi f L)^2}$, which represents the impedance of the coil. Since only a very small part of the talking current will pass through a 2000 ohm coil, so the ringing current at 60 cycles will be small when passed through the 2000 ohm coil. The low frequency ringing current, however, passes through the 2000 ohm coil easily on account of the impedance being small, thus ringing the 1000-ohm bell connected in series with it. In order to obtain an impedance coil in which the impedance may be easily varied artificially, the American Electric Telephone company has adopted a laminated core made of E-shaped annealed iron punchings, which can be readily inserted and withdrawn from the impedance coil when it becomes necessary to change the impedance so as to adjust the coils for unusual line or switchboard circuit conditions. By adding iron punchings, the impedance of

coil is increased for more lines of force will thread the coil or vice versa.

The 2 micro-farad condenser is placed in series with the low frequency bell to prevent a metallic grounding of the line, thus preventing any battery leakage or loss. The opposition of the flow of an alternating current through a condenser varies inversely with the frequency of the current, that is, it decreases with an increase in frequency or vice versa. This can be shown very plainly by the well known formula

$$C = \frac{E}{\sqrt{R^2 + \left(\frac{1}{2\pi f S}\right)^2}}$$

when there is capacity in the circuit. When the frequency is increased the value of $\left(\frac{1}{2\pi f S}\right)^2$ becomes less, thus making the value of the impedance or opposition $\sqrt{R^2+\left(\frac{1}{2\pi f S}\right)^2}$ less. A moderate capacity condenser is used to assist in making the operation of the low frequency bell better, for it tends to neutralize the effect of the impedance coil at the desired low frequency, and has little or no effect in opposition to the current at the high frequency. A condenser can readily be chosen to counteract the inductive effect of an impedance coil at a definite frequency by making the values of $2\pi f L$ and $\frac{1}{2\pi f S}$ the same for the expression of the impedance of a circuit containing capacity, and inductance is $\sqrt{R^2+\left(2\pi f L-\frac{1}{2\pi f S}\right)^2}$. Currents of high frequency like talking currents pass through conden-

sers very easily, but a low frequency or direct continuous current does not pass through the condenser because the impedance or opposition, $\sqrt{R^2+\left(\frac{1}{2\pi f S}\right)^2}$ is too great.

The high frequency instruments' ringing circuit is arranged with a 1000-ohm ringer in series with a three-tenths micro-farad (.3 M.F.) condenser and a 1000-ohm impedance coil bridged around the 1000-ohm ringer. The connections for the ringing circuit of the high frequency telephone are shown in Diagrams B & C. The capacity of this condenser was so chosen that it would permit the high frequency current to pass through it readily but to practically prevent the low frequency current from passing through. A low frequency current meets with greater opposition from a condenser than a high frequency current as has been shown. Thus the condenser is made to control the operation of the bells. The 1000-ohm impedance coil is bridged across the ringer so as to divert any low frequency current which passes the condenser from the ringer coil, while it offers sufficient opposition to the high frequency current to cause the majority of this current to pass through the ringer coil. The action of ringer is therefore made more positive. The value of the impedance of the coil is much greater than that of the ringer, because the former has a closed iron circuit.

When iron is removed from the impedance coil in the low frequency instrument the current through the ringer coil is increased, while a removal of iron from the impedance coil

in the high frequency instrument, the current flowing through the high frequency ringer coils is reduced.

The chief advantages of this system are as follows:-

(1). No adjustable springs or relays are necessary for the operation, because the conditions under which the system works is purely electrical in character and not mechanical.

(2). Adaptability to all sorts of conditions of line and switchboard circuits.

(3). Absolute protection against loss of current, condensers being connected in series with the equipment.

(4). Adaptability to use of standard ringers and condensers.

APPARATUS.

In performing the tests, the following apparatus was made use of. Two hand magnetos, one wound for the high frequency and the other for the low frequency ringing currents were driven separately by a Single Phase, 1/6 H.P. Emerson Self Starting Alternating Current Motor, pressure-104 volts, frequency of 60 cycles and speed of 1700 revolutions per minute. A steel pulley having three grooves in it, the circumferences of which were respectively 7.97 cm., 11.94 cm. and 16.03 cm. was fastened to shaft of motor by a set screw. A brass pulley with a groove in it similar to the steel pulley was also made and fastened on the shaft of the hand magneto. The circumference of the groove of the pulley on low frequency hand magneto was 17.09 cm. and that on the high

frequency one 5.66 cm. so that when the sewing machine belt was placed on middle groove, the low frequency hand magneto gave a voltage of 20 cycles and the high frequency, 60 cycles. The following frequencies were thus to be had 13.3,20 26.6,40,60, & 80 cycles per second. The alternating current to run the motor was obtained from the city at 110 volts and 60 cycles. Four selective telephones and extension bells,together with other specially wound bells were used. Also various capacities and different impedance coils were necessary. To measure the current flowing through ringing circuit a Rowland's electro-dynamometer was used and an alternating current voltmeter was utilized to measure the pressure. The impedance is then obtained by dividing the pressure by current.

In the experimental work it was desired to first find what the limits of this signaling system might be with increase of the impedance of the line, also to find the effect of increase of capacity. That is, to obtain data regarding the length of line over which the instruments as constructed can be operated.

Second, to determine the effect of varying the reactance and capacities used in the instruments, and also of these quantities on the reliability of operation of the system.

In performing the first experiments the telephones were placed in the circuit and then resistance was inserted in the line till the telephone failed to operate fairly well.

Next the resistance was taken out and capacity placed in the circuit by bridging condensers across the line till the telephones again failed to respond. The same operation for inductances could not be carried out to the limit of operation as the necessary inductance was not available. The following results were obtained for the resistance and capacity.

HIGH FREQUENCY TELEPHONE.

Resistance	Frequency	Capacity	Inductance	Remarks
0	40	18 M F	0	Limit of operation
0	60	24 M F	0	" " "
0	80	30 M F	0	" " "
6500	40	0	0	" " "
12000	60	0	0	" " "
23000	80	0	0	" " "
0	40	0	3.600 h'ys	Could not reach limit of operation.
0	60	0	3.600 "	Could not reach limit of operation.
0	80	0	3.600 "	Could not reach limit of operation.

LOW FREQUENCY TELEPHONE.

Resistance	Frequency	Capacity	Inductance	Remarks
13000	13.3	0	0	Limit of operation
15500	20.0	0	0	" " "
20000	26.6	0	0	" " "
0	13.3	24	0	" " "
0	20.0	28	0	" " "
0	26.6	32	0	" " "
0	13.3	0	3.600 h'ys	Could not reach limit of operation.
0	20.0	0	3.600 "	Could not reach limit of operation.
0	26.6	0	3.600 "	Could not reach limit of operation.

From the foregoing tables it can be seen that for both the low and high frequency telephones the higher the frequency the greater can be the resistance and capacity of the line. This is probably due to increase in voltage of the magneto as no attempt was made to keep this constant. It will also be noticed that the inductance and capacity were considered to be zero when the resistance limit was being obtained. Therefore for a line which has resistance, capacity and inductance in it the value of the expression $\sqrt{R^2+\left(2\pi fL-\frac{1}{2\pi fS}\right)^2}$ which is the impedance of such a circuit should not exceed 15,500 ohms for 20 cycles in low frequency telephones nor 12,000 ohms for 60 cycles in high frequency telephones. The low frequency telephone can be operated over a slightly longer line than the high frequency telephone.

A telephone line which is constructed of No. 9 Brown and Sharpe guage wire, spaced 8 inches apart, has a resistance of 4.165 ohms per mile of wire at 75 degrees F., an inductance of .00167 henrys per mile of wire and a capacity of .00904 micro-farads per mile of wire.

The impedance can be found by substituting in the following formula $\sqrt{R^2+\left(2\pi fL-\frac{1}{2\pi fS}\right)^2}$. The impedance per mile of wire for 20 cycles is therefore equal to 4.22 ohms and for 60 cycles equals 4.18 ohms. Then a long distance line of 1000 miles has an impedance of 8,440 ohms and for 20 cyclesand 8,360 ohms for 60 cycles. The results obtained show that the telephones can operate over lines whose impedance

is greater than 8,440 ohms for 20 cycles and 8,360 ohms for 60 cycles.

For the second series of experiments the capacity and inductance of the bell circuits were varied so as to show their effect on the operation of the ringing circuit. In the low frequency telephones the impedance coil is in series with the ringer coil. First impedance coils of different resistances were placed in series with a 1000-ohm ringer coil and then the same operation was gone through with a 500-ohm ringer coil. The results obtained are shown in the following tabulated form.

LOW FREQUENCY TELEPHONE.

Case 1. 1000-ohm ringer coil.
1000-ohm impedance coil.

No. of Discs.	Freq.	E in volts	C in amps	Impedance in ohms	Remarks.
1	13.3	64.5	.574	112	Rang well.
4	"	64.0	.589	118	" "
7	"	63	.620	102	" "
10	"	62	.620	100	" "
13	"	65.5	.427	153	" "
1	20	84	.876	95.8	" "
4	20	82	.888	92.3	" "
7	20	81.5	.795	102	" "
10	20	88.5	.478	185	" "
13	20	90	.310	290	" "
1	26.6	103.5	.986	105	" "
4	26.6	105	.938	112	" "
7	26.6	107	.558	192	" "
10	26.6	110	.416	264	" "
13	26.6	117.5	.224	525	" "
1	40	87	.670	130	" "
4	40	89	.472	188	" "
7	40	91	.249	365	" "
10	40	90.5	.179	505	" "

13	40	91.5	.131	698	Rang fairly well
1	60	113.5	.716	158	" "
4	60	118.5	.377	314	" "
7	60	120	.203	592	" "
10	60	120.5	.169	714	" " "
13	60	120.5	.131	921	" slightly
1	80	152	.799	190	" well
4	80	158	.411	384	" fairly well
7	80	159	.251	635	" slightly
10	80	158	.176	899	" "
13	80	160	.135	1184	" "

<u>Case 2.</u> 1000-ohm ringer coil.
2000-ohm impedance coil.

No. of Discs.	Freq.	E in volts	C in amps	Impedance in ohms	Remarks
0	13.3	66	.370	178	Rang well
3	13.3	67	.310	216	" "
6	13.3	69	.169	408	" "
9	13.3	68.5	.107	639	" "
12	13.3	69.5	.104	668	" "
15	13.3	69.5	.096	732	" "
0	20	88.5	.569	155	" "
3	20	90.5	.334	271	" "
6	20	93.0	.182	511	" "
					Original One
9	20	92	.135	681	Rang well
12	20	93	.128	726	" "
15	20	92.5	.117	781	" "
0	26.6	111.5	.716	156	" "
3	26.6	116	.331	350	" "
6	26.6	116	.194	598	" "
9	26.6	116	.158	735	" "
12	26.6	117	.150	781	" "
15	26.6	116.5	.141	827	" "
0	40	92	.358	257	" fairly well
3	40	93.5	.165	566	" slightly
6	40				Would not ring
9	40				" " "

12	40				Would not ring
15	"				" " "
0	60	119.5	.395	303	" fairly well
3	"	122	.117	1042	" slightly
6	"				Would not ring
9	"				" " "
12	"				" " "
15	"				" " "
0	80				" " "
3	"				" " "
6	"				" " "
9	"				" " "
12	"				" " "
15	"				" " "

Case 3. 1000-ohm ringer coil.
4000-ohm impedance coil.

No. of Discs.	Freq.	E in volts	C in amps	Impedance in ohms	Remarks
1	13.3	66	.469	141	Rang well
4	"	66	.493	134	" "
7	"	66	.364	182	" "
10	"	68	.188	361	" "
13	"	68.5	.122	561	" "
1	20	89	.722	123	" "
4	"	94.5	.586	161	" "
7	"	93.5	.312	299	" "
10	"	94	.103	911	" "
13	"	92.5	.122	757	" fairly well
1	26.6	110.5	.856	129	" "
4	26.6	116	.517	224	" "
7	"	121	.310	390	" fairly well
10	"	123	.173	711	" slightly
13	"	122.5	.122	1004	" "
1	40	85.5	.516	165	" "
4	"				Would not ring
7	"				" " "
10	"				" " "
13	"				" " "

1	60	113	.541	209	Rang slightly
4	"				Would not ring
7	"				" " "
10	"				" " "
13	"				" " "
1	80				" " "
4	"				" " "
7	"				" " "
10	"				" " "
13	"				" " "

<u>Case 4</u>. 500-ohm ringer coil.
500-ohm impedance coil.

1	13.3	65	.777	83.7	Rang well
4	"	65	.789	82.5	" "
7	"	65	.770	84.5	" "
10	"	65	.788	82.7	" "
13	"	64	.792	80.8	" "
1	20	87	1.250	69.7	" "
4	"	87	1.280	68.0	" "
7	"	86	1.350	62.6	" "
10	"	84	1.390	60.4	" "
13	"	82.5	1.470	56.1	" "
1	26.6	107	1.880	57.0	" "
4	"	104.5	1.970	53.1	" "
7	"	101.5	1.970	51.6	" "
10	"	96.5	2.010	48.0	" "
13	"	94.5	1.970	48.0	" "
1	40	86	1.550	55.5	" "
4	"	82.5	1.530	53.8	" "
7	"	84	.765	109.5	" "
10	"	90	.676	133	" "
13	"	91	.423	215	" "
1	60	105.5	1.930	54.7	" "
4	"	106	1.480	71.6	" "
7	"	112	.947	118	" "
10	"	115	.573	201	" "
13	"	116	.394	294	" "
1	80	124	2.100	59	" "
4	"	134	1.460	89.8	" "
7	"	138	.888	156	" "
10	"	141	.541	261	" slightly
13	"	143	.790	181	" faintly

Case 5. 500-ohm ringer coil.
1000-ohm impedance coil.

No. of Discs.	Freq.	E in volts	C in amps	Impedance in ohms	Remarks
1	13.3	64	.676	94.5	Rang well
4	"	65.5	.691	94.9	" "
7	"	64	.704	91.0	" "
10	"	64	.778	82.2	" "
13	"	61	.801	76.1	" "
1	20	87	1.148	75.7	" "
4	"	85.5	1.232	68.4	" "
7	"	83	1.282	64.6	" "
10	"	84.5	1.200	70.3	" "
13	"	92	.515	178	" "
1	26.6	106	1.620	65.4	" "
4	"	100	1.670	60.2	" "
7	"	103	1.430	72.0	" "
10	"	116	.636	182	" "
13	"	119	.345	345	" "
1	40	85	1.250	68	" "
4	40	88	.816	108	" "
7	40	92	.369	249	" "
10	"	92.5	.203	455	" fairly well
13	"	92.5	.152	608	"slightly
1	60	107	1.480	72.4	" well
4	"	115	.691	167	" "
7	"	119	.318	374	" "
10	"	119.5	.208	574	" faintly
13	"				Would not ring
1	80	140	1.590	88	Rang well
4	"	155	.663	234	" faintly
7	"				Would not ring
10	"				" " "
13	"				" " "

Case 6. 500-ohms ringer coil.
2000-ohm impedance coil.

No. of Discs	Freq.	E in volts	C in amps	Impedance in ohms	Remarks
1	13.3	65.5	.590	111	Rang well
4	"	65.5	.635	103	" "

7	13.3	63	.690	91.3	Rang well
10	"	69	.253	272	" "
13	"	69	.143	482	" slightly
1	20	86	.948	90.7	" well
4	"	83	.995	83.4	" "
7	"	90.5	.574	157	" strong-est
10	"	93	.203	457	" well
13	"	94	.131	717	" slightly
1	26.6	106	1.280	82.8	" well
4	"	105	1.050	100	" "
7	"	116	.438	264	" "
10	"	118	.200	590	" "
13	"	119	.126	944	" slightly
1	40	83	.790	105	" well
4	"	88	.635	138	" fairly well
7	"	89	.131	680	" faintly
10	"				Would not ring
13	"				" " "
1	60	109	1.030	106	Rang well
4	"	117.5	.295	399	" faintly
7	"				Would not ring
10	"				" " "
13	"				" " "
1	80	146	1.110	132	Rang well
4	"	157	.287	547	" faintly
7	"				Would not ring
10	"				" " "
13	"				" " "

In the above tests it is shown that when the impedance coil has the same ohmic resistance as the ringer coil the impedance coil does not offer to the high frequency currents sufficient resistance to keep them from operating the bell of ringer, and that when the impedance coil has four times the resistance of the ringer coil, it offers a little too much resistance to the low frequency current. The best

results seem to be obtained when the impedance coil has twice the ohmic resistance of the ringer coil. This seems to offer a compromise between the other two. The selection appears to be better when the ringer coil has an ohmic resistance of 1000 ohms than when its resistance is 500 ohms, and the action is also more positive.

With the high frequency telephone, the inductance and capacity were both varied. The effect of varying the same is shown in the following table:

Frequency	Ringer coil Resistance.	Impedance coil resistance.	Capacity of cond. in M.F.	Discs	Total		Imped coil		Ringer coil		Remarks
					E	C	E	C	E	C	
20	1000	300	.33	1	99.5	.703	99.2	.590	99.3	.117	Rang slightly with 2 discs.
20	"	500	.33	1	99.2	.741	100.4	.650	100.3	.124	" " " "
20	"	1000	.33	1	97.3	.649	98.5	.469	98.8	.203	" " " "
20	"	2000	.33	0							Would not select
20	"	300	.20	1	100	.677	101	.588	100.8	.112	Rang slightly with 2 discs.
20	"	500	.20	1	99.5	.704	100.5	.605	100.5	.117	" " "
20	"	1000	.20	1	97.5	.621	98	.449	97.8	.200	Rang slightly
20	"	2000	.20								Would not select.
20	"	300	.10	13	98	.303	99.2	.214	98.	.089	Would not ring.
20	"	500	.10	2	97.5	.379	98.3	.295	99	.083	Rang with 3 discs.
20	"	1000	.10	1	98	.352	99	.235	99.2	.131	" " 2 "
20	"	2000	.10	1	97	.318	98	.166	98	.151	Rang slightly
20	"	300	.05	13							Would not ring.
20	"	500	.05	13							" " "
20	"	1000	.05	13							" " "
20	"	2000	.05	13	97.2	.107	97.4	.017	98.5	.101	Rang very faintly.

From the foregoing tabulation, it is shown that the high frequency instruments do not select when the capacity of condenser is .3 micro-farads and the line is very short, but will select when a .05 micro-farads condenser is used. The tabulation also shows that the capacity of condenser, resistance of impedance coil and the resistance capacity and inductance of line must be so adjusted as to prevent low frequency currents passing through the ringer coil exceeding .10 ampere in value. If the low frequency currents exceed .10 ampere the ringer will operate thus making the instrument non-selective.

In conclusion, it may be said that in

The Leich Four Party System the operation of the telephones from the standpoint of selective ringing seems to be good on long lines, but not so good on short ones, expecially in the case of the high frequency telephone. The system can be made selective however by adjusting the capacity of condensers and the resistance of impedance and ringer coils to suit the conditions of line on which the instruments are to be operated. An instrument adjusted for one particular line needs to be readjusted when placed on another line having conditions which differ greatly. When once adjusted however the instruments are very reliable for selective ringing. They are especially convenient from a mechanical standpoint as the operation of the telephones is

purely electrical in character and no adjustable springs and relays are necessary. The low frequency telephones as constructed do not need to be improved on as it operates fairly well for all conditions of line. The high frequency telephones however could be improved by decreasing the capacity of the condenser to a value of .05 micro-farad or less, or by adjusting capacity and impedance so that the low frequency current passing through ringer coil does not exceed .10 ampere. By sufficient care the operation of the Leich Four Party Selective Signaling System can be made very reliable.

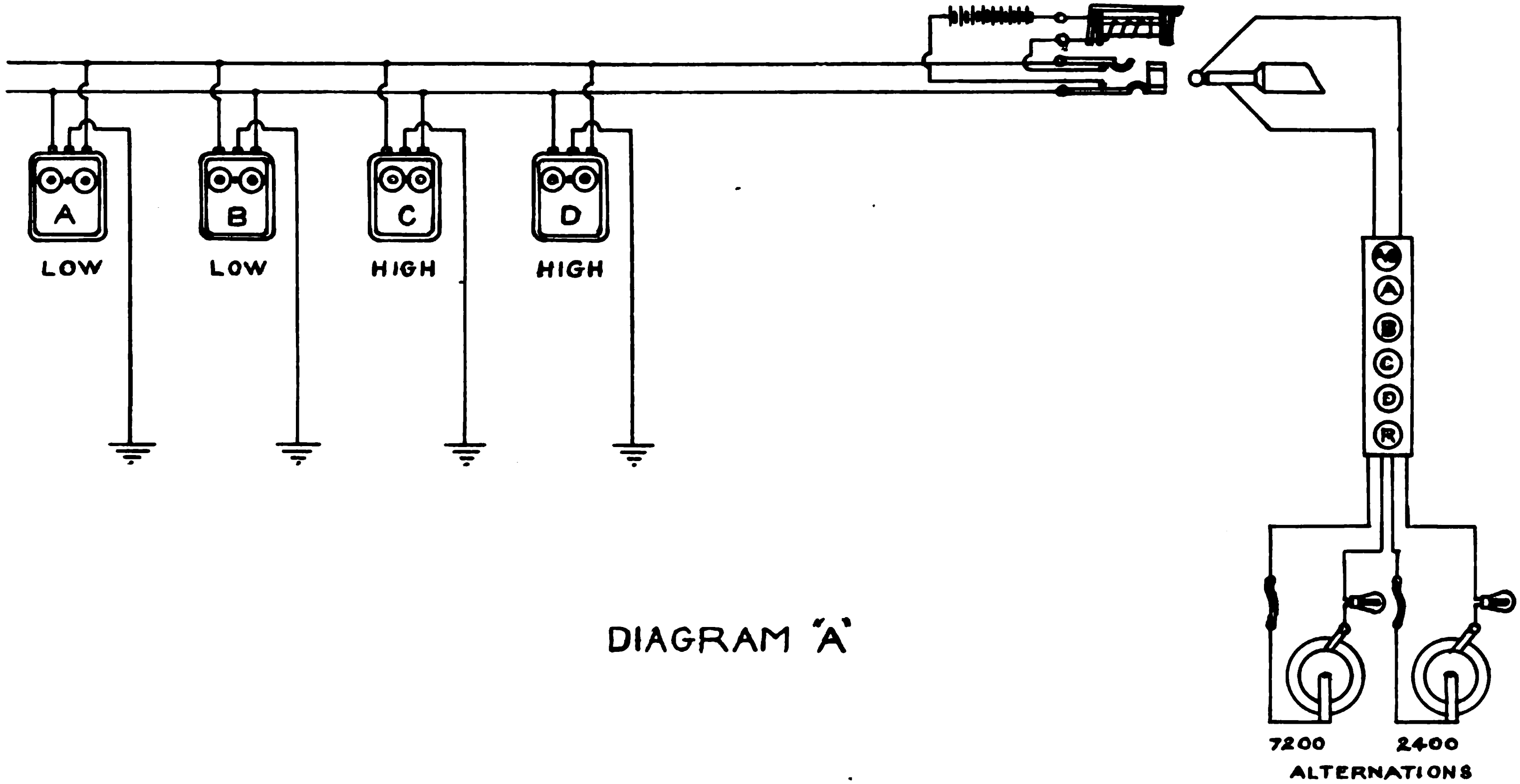
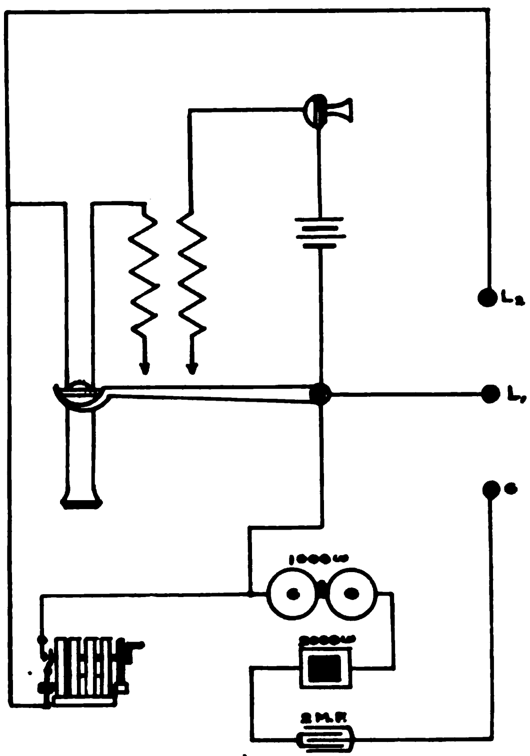


DIAGRAM "A"

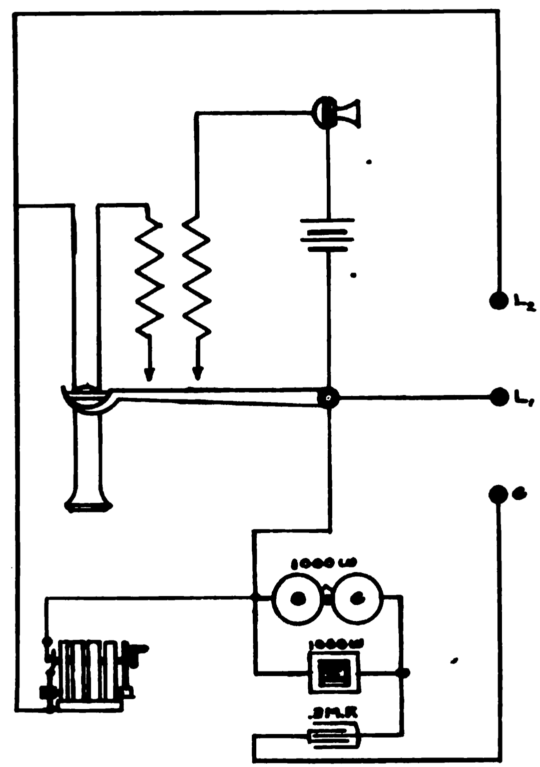
DIAGRAM "B"

MAGNETO

SELECTIVE TELEPHONES



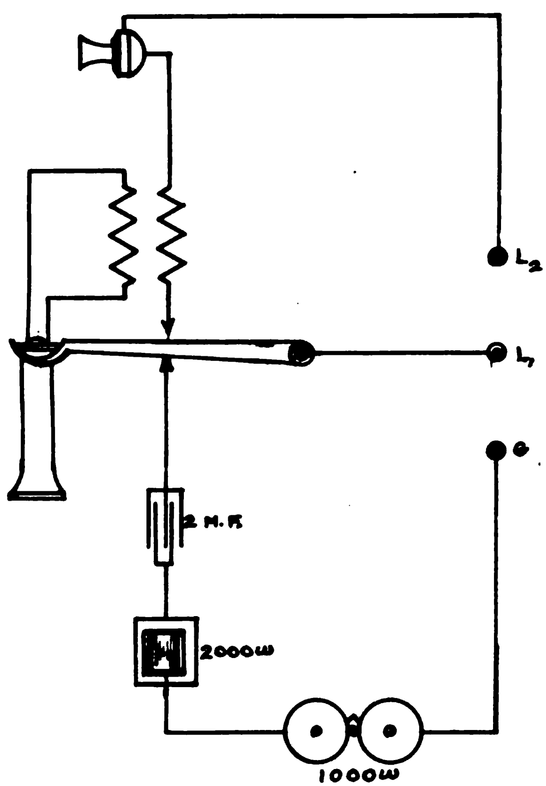
LOW FREQUENCY
INSTRUMENT CIRCUIT



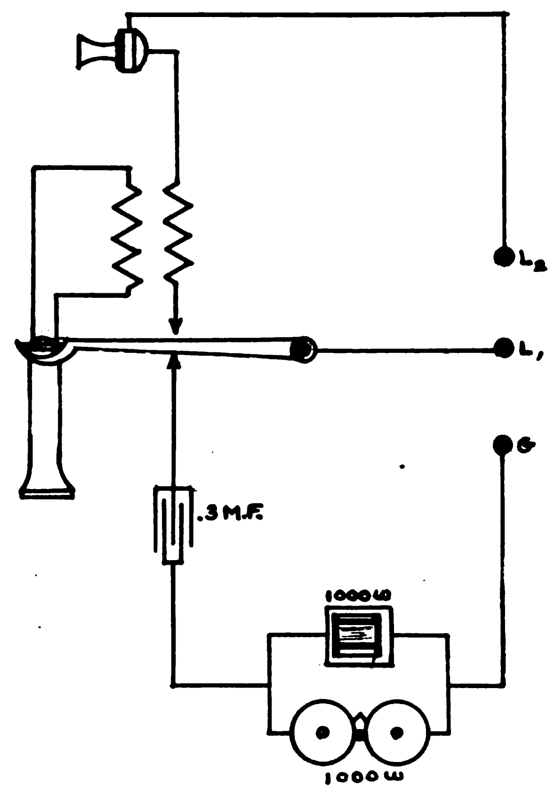
HIGH FREQUENCY
INSTRUMENT CIRCUIT

DIAGRAM "C"

CENTRAL ENERGY
SELECTIVE
TELEPHONES



LOW FREQUENCY
INSTRUMENT CIRCUIT



HIGH FREQUENCY
INSTRUMENT CIRCUIT

Approved by Geo. C. Shaad

Assist. Professor of Elec. Eng.